Integration of Electrochromic Glazing with Traditional Shading Techniques

Multivariate Analysis for Optimal Configuration

Sravanthi Musunuru
M.S. Sustainable Design 2014 Candidate
School of Architecture, College of Design
University of Minnesota, Twin Cities

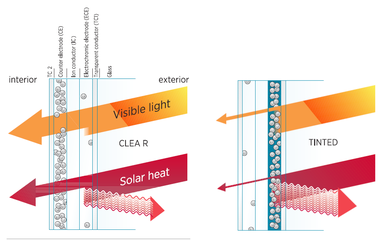
Abstract

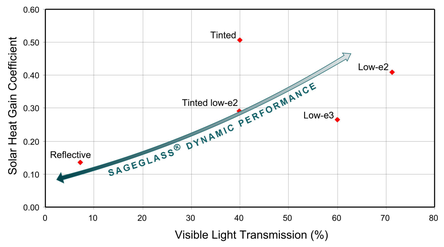
With the advancements in modern energy-efficient building envelopes, glazing systems have become more prominent as considerable heat transfer elements especially in curtain-wall systems making it extremely difficult for even high-performance static glazing systems to achieve very low energy consumption levels. This is when electrochromic glazing proves to be effective by adapting to both internal and external climatic conditions, hence reducing energy consumption and increasing occupant comfort. But a curtain-wall glazing system entirely of electrochromic glazing might not be the most economical solution for effective daylighting and energy efficiency. The portion of glazing below 2.5ft from floor level (non-vision glazing) does not provide views or useful daylight at workspace height and that above 7.5ft from floor level (daylight glazing) is most effective for daylight penetration when coupled with internal light-shelves to distribute daylight deep into the interior space. This provides an opportunity to tailor the vertical design of the envelope to better respond to different performance and design issues.

This multivariate study analyzes the energy efficiency, daylight availability and glare potential of various combinations of electrochromic glazing (SageGlass) and traditional shading techniques namely external shading devices and internal light-shelves. The ultimate goal is to study the interaction between electrochromic glazing and traditional shading techniques and identify the optimum configuration(s) that reaps the maximum quantitative and qualitative performance benefits, hence discovering a more sustainable solution while also making a business/ economic case (w.r.t. associated energy savings) of replacing static property glazing with dynamic property electrochromic glazing.

Background

SageGlass is electronically tintable glass for windows, skylights and curtain walls. It controls sunlight without shades or blinds, so that glare and heat can be managed while maintaining a connection to the outdoors. But due to its relatively higher initial cost, it is not being used extensively to its highest potential.





Objectives

1. Study the interaction between electrochromic glazing and traditional shading techniques and identify the optimum configuration(s) that reaps the maximum quantitative and qualitative performance benefits while maintaining 100% view potential.

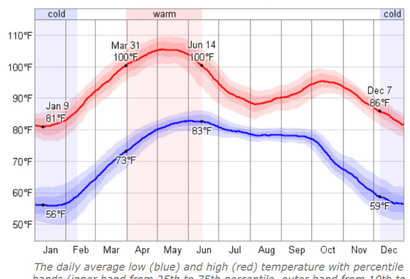
2. Discover a more sustainable solution while also making a business/ economic case (w.r.t. associated energy savings) of replacing static property glazing with dynamic property electrochromic glazing.

Analysis Weather Data

Location : Ahmedabad, India
Climate : Hot-Dry
Latitude : 23 degrees

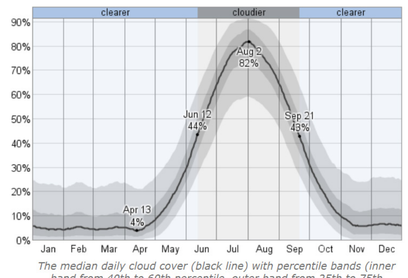
Cloudiest Day : August 2
Clearest Day : April 13
Average cloud conditions : September 21

Daily High and Low Temperature



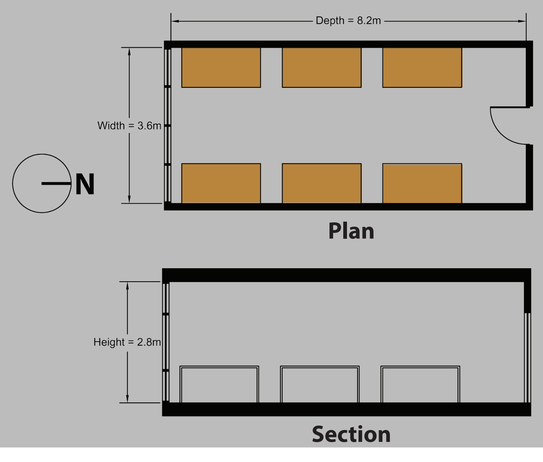
The daily average low (blue) and high (red) temperature with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

Median Cloud Cover



The median daily cloud cover (black line) with percentile bands (inner band from 40th to 60th percentile, outer band from 25th to 75th percentile).

Reference Office Base Case

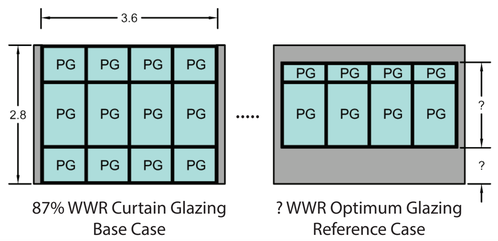


- Plain Double Glazing Curtain-Wall System
- U-Value = 1.6 W/m2K (heat transmittance)
- SHGC = 28% (Solar Heat Gain Coefficient)
- VT = 65% (Visual Transmittance)
- WWR = 87% (Window to Wall Area Ratio)

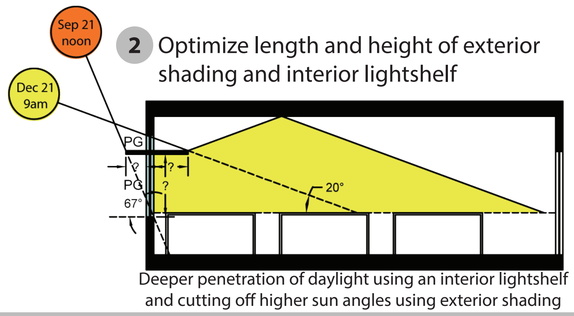
Research Methodology

Plain Glazing

1 Optimize WWR (Window to Wall Area Ratio)

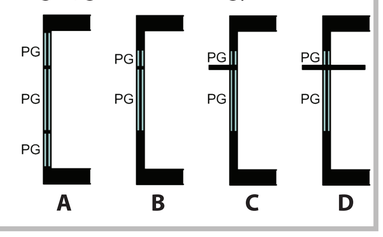


2 Optimize length and height of exterior shading and interior lightshelf



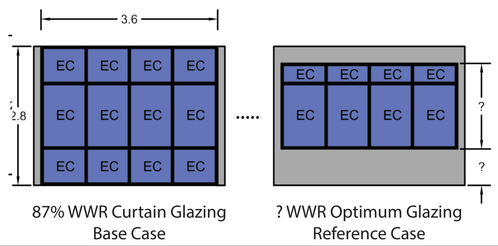
Deeper penetration of daylight using an interior lightshelf and cutting off higher sun angles using exterior shading

3 Establish cases and simulate daylight, glare and energy use

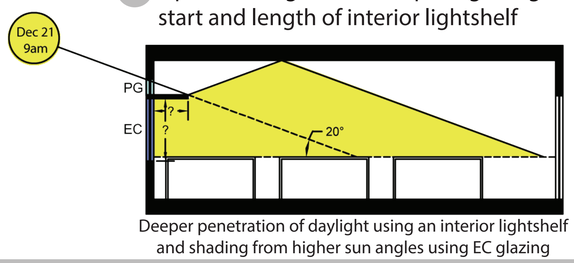


Electrochromic Glazing

4 Optimize WWR (Window to Wall Area Ratio)

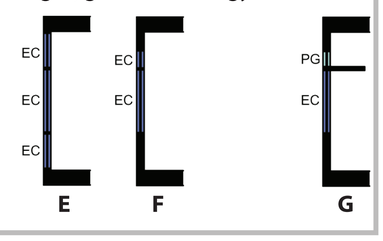


5 Optimize height at which plain glazing can start and length of interior lightshelf

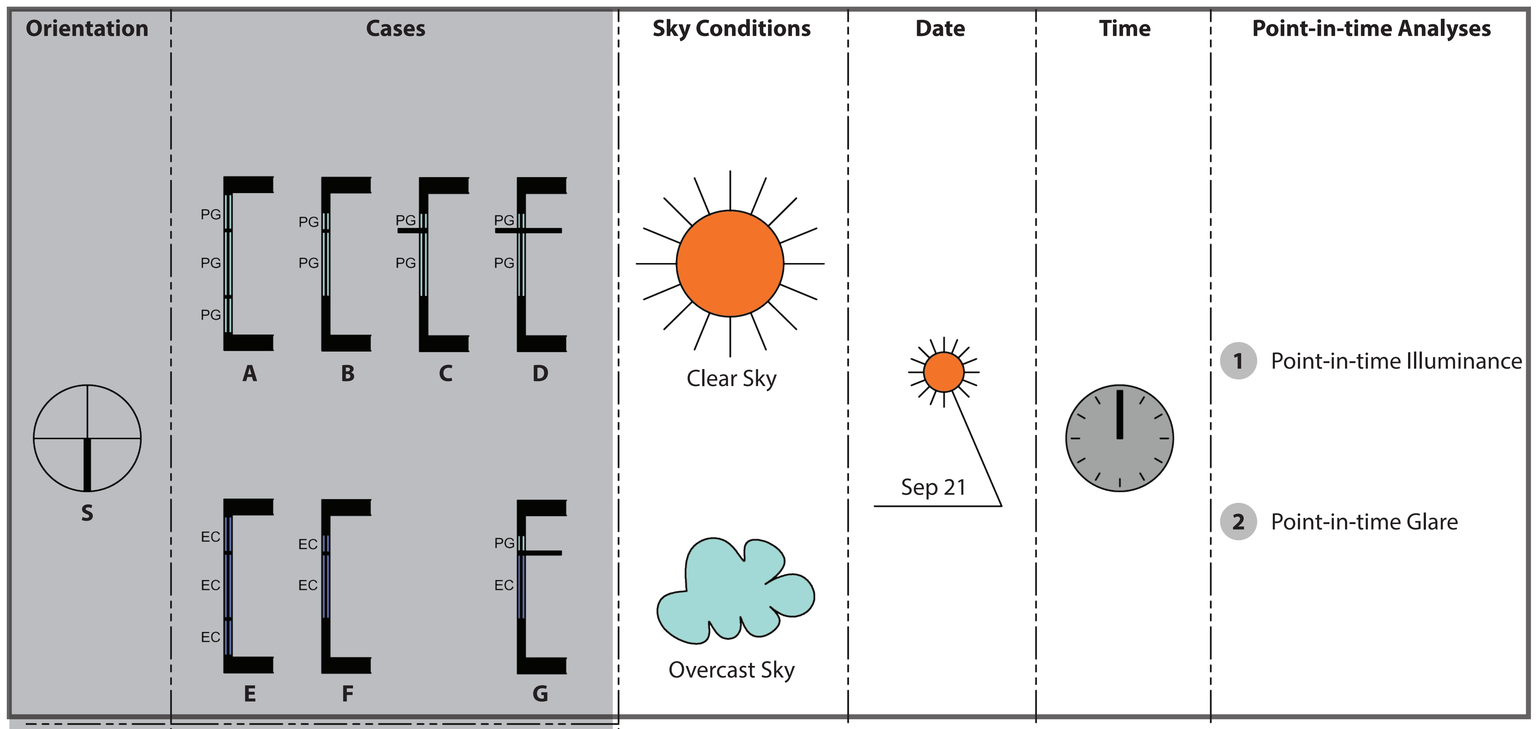


Deeper penetration of daylight using an interior lightshelf and shading from higher sun angles using EC glazing

6 Establish cases and simulate daylight, glare and energy use



Research Design

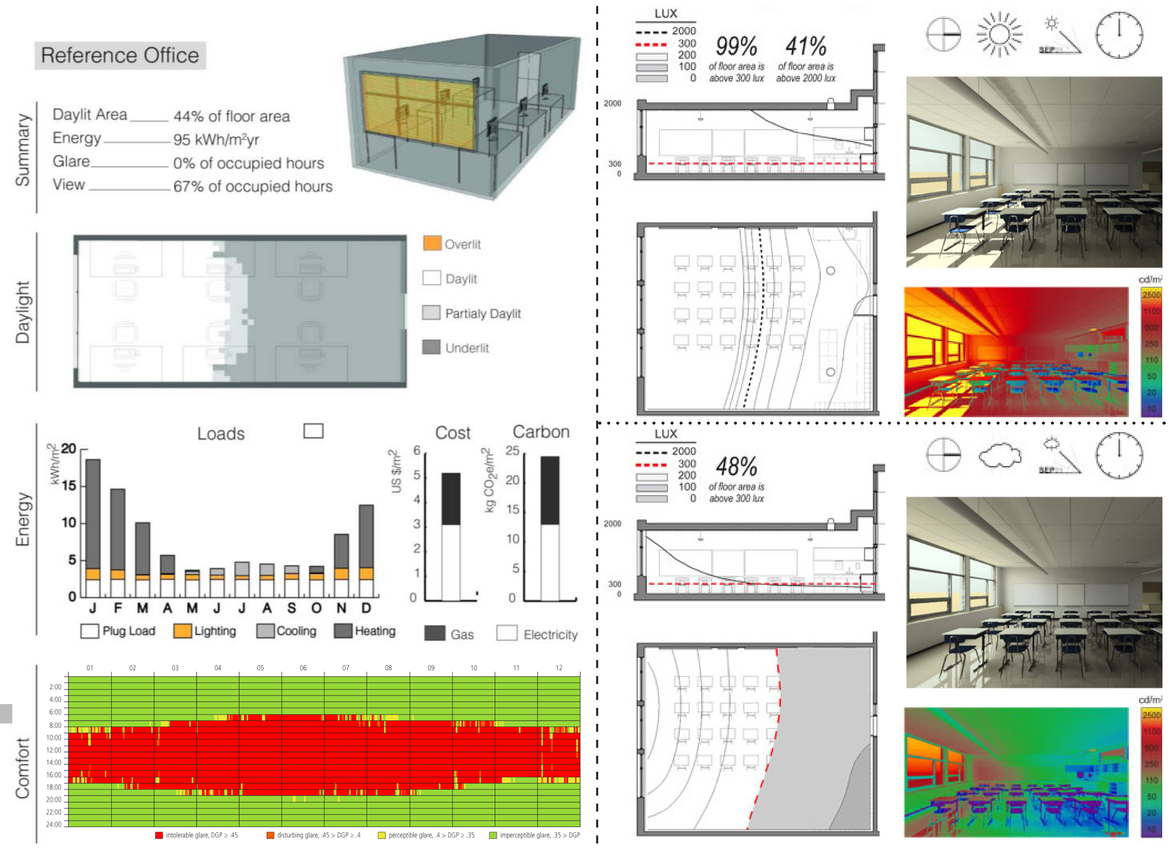


(1 orientation) x (7 cases) x
[(3 annual analyses) +
{ (2 sky conditions) x (1 date) x (1 time) x (2 point-in-time analyses) }]
= 49 analyses

Sample Analysis Results

Case B:
Optimized WWR Plain Glazing

Every climate is unique and hence unique should be the properties of the glazing as well. The hot-dry climate of Ahmedabad demands that the heat from the sun should be cut off as much as possible but let the winter sun penetrate deeper into the space. The higher altitudes of the sun owing to the lower latitudes make this task challenging.
Optimizing WWR is the first step to achive this. Higher sill levels ensure that the heat from the high sun angles in summer is cut off as much as possible while still letting the lower winter sun in. To the right are shown the various analysis run to determine the amount of daylight, glare and energy use in the optimized WWR case.



References

- C F Reinhart et.al., "Definition of a Reference Office for standardized evaluations of dynamic facade and lighting technologies", Proceedings of Building Simulation 2013, Chambery , France, August 2013.
- Daylighting Pattern Guide. Integrated Design Lab et.al., n.d. Web. 10 Apr. 2014. <http://patternguide.advancedbuildings.net/>.